Instructor Premium

COMPUTER CONFIDENCE

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EVERYTHING YOU NEED TO KNOW TO USE COMPUTERS EFFECTIVELY IN THE CLASSROOM!

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INTRODUCTION

Computers! What good are they?

This is a question many teachers are asking today. And it's a vital question, since many schools are faced with painful choices about where best to invest the taxpayers' dollars—books, supplies, or computers.

It's also important because computers are changing the way teachers teach. In 1982 more than 14 percent of all elementary and junior high schools were teaching with computers; 43 percent of all high schools. The number of schools using computers for instruction has been growing by more than 34 percent each year.

Computers! What good are they?

The answer is far from simple. Indeed, the truth is that, as a teacher, you must discover the answer for yourself. The fact that your colleague in the room next door is a computer whiz and is always talking up computers doesn't help you in the least. Nor does the fact that the teacher across the hall wants to deep-six every computer in the universe and banish every computer jock to the moon.

Computers! What good are they?

The only way that you can answer this question is by digging in and discovering the answer for yourself. That's what this book is all about—helping you penetrate the technofog that surrounds computers. This book will help you discover what you, as a teacher, need to know about computers—what they are, how they work, what they can do to make your job easier, and more important, what they can't.

Computers— What They Do. How They Work

Let's start with a simple fact that is often lost in the hoopla about computers. **A computer is a tool, nothing more nor less.** This means that a computer is useful only if it helps you do a better job, or the equivalent job faster or cheaper.

But there's a corollary to this fact. The usefulness of a tool is determined by the skill and imagination of the worker. And it's just this fact that scares a lot of teachers away from computers. They see that there's a lot to learn; they feel that it will take too long to learn what they need to know to use the computer effectively as a tool in the classroom. Moreover, they fear that they'll look and feel foolish while they're learning.

It's just not true. You can learn everything you need to know to make a computer useful in less than 20 minutes. On the other hand, computers are so versatile that you can go on learning for the rest of your life and never learn it all. Moreover, learning about computers is fun.

So computers are tools. What kind of tools? They are tools for working with symbols and logic—numbers and number systems, words and languages, pictures and presentations, sounds and music—everything from guiding the space shuttle to counting hamburgers, from making television commercials to talking with dolphins. If the job involves symbols and logic, people have found ways to make the computer useful.

But this is the other thing that has scared teachers. Because the computer deals with symbols and logic, they assume that it has a mind of its own, some kind of malevolent consciousness. Some teachers even fear that computers will take over their jobs.

Sorry. A computer is just a machine—more versatile than a food processor; less intelligent than a newt. Behind every computer with designs on the world there's a hack writer with a feverish imagination or a computer user with delusions of grandeur. As far as your job is concerned, David Ahl, publisher of *Creative Computing* magazine, has said that "any teacher who can be replaced by a computer probably should be."

On the other hand, if anyone tries to tell you that computers won't have major impact on education, they have their heads in the sand.

Benefits

Let's get down to brass tacks. Here's a simple symbol/logic-type problem:

$$\begin{array}{r} 758{,}498 \\ \times\ \underline{638{,}927} \end{array}$$

How long would it take to solve this problem in your head? How likely is it that you'll come up with the right answer?

All right, we'll be generous and let you use paper and pencil. Even with paper and pencil, how long will it take you to solve this problem? And how much have you improved your chances of getting it right?

Based upon actual experience, it takes the typical classroom teacher about five minutes to solve this problem. About one in three get it right the first time and another third refuse to even give it a try. We doubt that engineers or accountants could do much better.

"So what's the point?" you say. "It's a stupid problem that any idiot can solve without the least bit of imagination. Besides, with a calculator I can knock out the answer in three seconds flat."

That's just the point. Why should we waste our time with boring problems when there are so many more important and creative things to do? If we can find a tool to make the boring stuff easier, why not use it? Incidentally, a calculator is nothing but a computer with severe limitations.

So that's Point 1. **Computers help us solve routine problems that are so boring we'd rather not bother with them at all.**

Point 2 is that **computers can do this very rapidly.** Did we say five minutes with paper and pencil? Our computer just solved 1,000 such problems with 1,000 addition problems thrown in for good measure in just under seven seconds. And it's a very modest little computer—slow as molasses so far as computers go.

Because computers are so fast, they enable us to take on problems that we wouldn't otherwise dare try. After all, who wants to spend a week of Sundays multiplying six-digit numbers?

Limitations

To solve the problem given above on our computer, we typed the following line on the keyboard:

```
PRINT 758498 * 638927
```

The computer solved it faster than we could blink. While we must give the computer credit for speed, however, the * demonstrates how dumb it is. The computer that we used doesn't know that the symbol × can mean more than one thing depending upon the context. As every fifth grader knows, in one context it's the first letter of the word "xerography," in another it tells you to multiply two numbers together. If we used × in our instruction to the computer, it would think that we meant one thing when, in reality, we meant quite another. To the computer, the symbol * as used above means multiplication. × means something else.

As you'll learn soon enough, computers are exasperatingly literal. Moreover, the computer hasn't the foggiest notion as to what the two numbers mean or why we'd want to multiply them to begin with. We could be working on a cure for cancer or handicapping racehorses. To the computer it's all the same.

Programs and programming

Did you ever have to stay after school to write your name 1,000 times? We inflicted this job on our computer. Here's what we typed on the keyboard to tell it what we wanted it to do:

```
10 FOR 1 = 1 TO 1000
20 PRINT "FYODOR M. DOSTOYEVSKY"
30 NEXT 1
RUN
```

It finished in 20 seconds flat and didn't seem to mind a bit.

''Aha!'' you say, ''I know you'd get technical. Programming!''

Yes, we had to write a little program to tell our computer what we wanted it to do. It was written in a computer language called Basic. But there are several things that you should know about this.

First, you don't have to know a thing about programming to use computers effectively. Professional programmers are cranking out an amazing number of useful programs. They sell these programs to people who want to use computers but either don't have time to program or don't know how. By the beginning of 1973, there were nearly 1,000 programs written by professional programmers for use in schools. Many were developed and distributed by major publishers, and they ranged in price from $9.95 to more than $1,000. Most programs for education cost less than $50. It takes hundreds of hours to write a useful program, so even if you know how to program, for $50 it makes sense to let someone else do it for you. About all you need to know to use such programs is how to turn on the computer, load the program, read, and do what the directions on the screen tell you to do. Some programs are slightly harder—you have to read the instructions.

You can learn how to turn on the computers and load a program in two minutes or less. The process varies a bit from computer to computer, but it goes something like this:

Step 1—Insert the program, which is magnetically recorded on a floppy disk, into the disk drive.
(Note: A floppy disk is a storage medium for computer programs and data. A disk drive is a gadget somewhat smaller than a shoe box that comes with the computer. It has a slot in the front. Loading a disk into a drive is much like sticking a letter into a mailbox.)

Step 2—Turn on the computer's main power switch.

This is the nifty part—right after you turn on the power switch, the computer loads the program itself.

Here are some things to know about programming. Think about a carpenter and his tools for a moment. A carpenter carries around a kit of tools as he goes about his job—hammer, saw, square, bubble level, chisel. Think how happy he would be if he had to carry around only one tool—a magical all-purpose carpenter's tool. When he finishes sawing a board in half he need only look at his magical tool and say, “Saw, I want you to be a hammer!” and bingo!

Remarkably, computers are even more versatile—all because of programming. When you load a program into a computer, it becomes a particular type of tool. When this manuscript was being typed, our computer became a word processor, a tool that makes typing much easier than if we'd had to type it on a regular typewriter. At other times our computer is an electronic filing cabinet for storing and retrieving information, or a bookkeeping tool to help keep budgets straight, or an entertainment tool, or a learning tool. All we have to do is change the program.

Hardware and software

Now we're ready for some jargon. The parts of a computer that you can see, feel, taste, or smell are called *hardware*. The instructions that tell the hardware what to do—that is, the various programs that are loaded into the computer—are called *software*. Computer hardware is designed to work with as broad a range of symbol/logic-type problems as the designers can think of. The software makes the computer behave like a tool when you have a specific job of work to do. Change the program and you create a new tool. Since programmers can create an infinite variety of programs, a computer is essentially a bottomless toolbox.

A particular combination of hardware and software is called a *computer system*. A computer system processes *input data* to create *output*. Input data are simply the words or numbers that you enter into the computer. The words of this book that were typed into the computer were regarded as input data by our word processing system. When the word processing system did its job, which was to handle all of our editing changes, it printed out a crisply typed manuscript. This manuscipt is the output. The word processing program that was loaded into our computer told the hardware what steps to take to turn the input data into output.

Let's examine another program—a simple one.

```
10 INPUT A
20 INPUT B
30 LET C = A * B
40 PRINT C
```

If you type this program into a computer set up to run Basic, then type RUN, here's what happens: first the computer carries out, or executes, the instruction in line 10, It prints a question mark on the screen. This is the computer's way of saying that it wants you to type in a number. When you type a number on the keyboard and press the return key, the computer stores your number in its memory. Line 10 tells the computer to call the place where it stores the number A. Line 20 tells the computer to get another number from you and store it in an area of memory called B. Line 30 tells the computer to multipy the numbers stored in memory areas A and B and store the result in memory area C. Line 40 tells the computer to print the result stored in memory area C on the screen. Neat and simple—a handy-dandy multiplication tool. Note that the program (software) tells the computer (hardware) what to do, but the hardware does the work.

Here's a useful way to think about programs. A program is nothing more than a recipe written in a more-or-less fussy language that tells the computer hardware how to whip up some input data into savory and useful information. Information is data that is meaningful or useful to the user.

Decisions

While a computer has many limitations, it has the ability to make certain kinds of decisions. It's this ability that gives the computer its seeming intelligence and makes it stand out from other machines. The following program is a simple example. See if you can figure out what it does and how it works:

```
10 PRINT “TYPE IN YOUR AGE”;
20 INPUT A
30 IF A => 18 THEN PRINT “YES, YOU CAN VOTE”
40 IF A < 18 THEN PRINT “SORRY, YOU’RE TOO YOUNG TO VOTE”
```

Hint: => means “equal or greater than” and < means “less than.”

The naming of parts

Five main hardware subsystems go together to make up a computer—input, central processor, main memory, output, and mass storage. Let's look at these subsystems one at a time.

Input—Computer designers have come up with many ways of entering data into computers. A few years ago punched cards were most common. Today punched cards are all but obsolete. Now the most common method is a typewriter-like keyboard. The joysticks that youngsters use to play video games are another type of input device, as is the graphics tablet—you draw on the tablet with a special pen and the computer stores the resulting illustration in memory. Some computers can even accept spoken commands and data.

But this is just the beginning. Data can be generated by any event in the universe, from an exploding star to a musician's day-dream. If the data can be transformed into an electrical signal, it can be entered into a computer by one kind of input device or another. The fact is that no matter how exotic the data, the input subsystem ultimately transforms it into a binary pattern. That is, flips a bunch of electrical switches inside the computer on and off in a particular pattern to represent the data.

Remember Paul Revere? He was instructed to turn on one lantern if the British marched toward Lexington by land and two if they traveled in boats by sea. If you picture Paul in his belfrey with thousands of lanterns and imagine the countless variety of ideas that he can represent by turning the lanterns on or off in particular patterns, you'll begin to get an idea of what goes on inside the computer.

Central processor—Imagine the central processor as a faithful clerk with a pile of instructions on his desk. He's obsessive. Quick as a wink he fetches an instruction and carries it out. And again he fetches an instruction and carries it out. And again. All day long, millions of times a second, without error or fatigue, he fetches instructions and carries them out. The instructions are stored in the computer's memory. How did they get there? You put them there when you loaded you program.

From your point of view, the instructions tell the central processor to do something useful like multiply two six-digit numbers. All the central processor sees, however, is a set of switches turned on or off in a particular pattern. Each pattern tells the processor to do something different with still another set of switches—turn some on and others off. This new pattern will ultimately be translated by the computer's output subsystem into information that will be of use to you.

Memory—By now you've probably figured out that there's nothing magical about how the computer remembers numbers, words, or other types of data. It flips a bunch of electronic switches. A particular on/off pattern represents a particular number or character.

You can think of the computer's memory as a long row of post office boxes. Each box has a particular address so that the central processor can keep track of what's stored where. The typical Apple II microcomputer, for example, has more than 48,000 memory locations, each with a particular address. Each memory location is actually a row of eight switches. In computer lingo each switch is called a *bit*, and eight bits organized as a single memory location are called a *byte*. Since most computers have many bytes of memory, people often refer to *kilobytes*. A kilobyte is 1,024 bytes of memory. The Apple II usually has 48 kilobytes, abbreviated 48K, of memory. The character A stored in a particular memory location would look like this:

Memory Location of A

Switch	1	2	3	4	5	6	7	8
State	off	on	off	off	off	off	off	on

For all practical purposes, a single character such as A takes up one byte of memory.

It turns out that most computers have two types of main memory. *Read Only Memory*, or *ROM*, contains switches that can't be changed by the central processor. The pattern is set at the factory. ROM usually contains programs that tell the computer what to do when you first turn it on. It also contains programs that tell the central processor how to read the characters that the user types on the keyboard, how to display characters on the display screen, and how to perform other useful things.

The other type of memory is called *Random Access Memory*, or *RAM*. The central processor can store data in RAM and read it back later. When you type data into the computer, it's stored in RAM. When the computer processes your data and produces a result, it's often stored in RAM. When the central processor needs a temporary scratch pad for intermediate results, it uses RAM. The difference between ROM and RAM, in other words, is like the difference between a reference book and a notebook.

Output—The output subsystem transforms the cryptic patterns of switches inside the computer into information that is meaningful to the user. Video display screens, either video monitors or regular television sets, are the most commonly used output devices today. The microcomputers commonly found in classrooms can display either text or graphics on the video screen. Another important output device is the printer. A printer provides hard copy of information produced by the computer. In addition to display screens and printers, many computer systems have some kind of sound output. Given the right kind of output devices, computers are outstanding musical instruments, although some of the more popular classroom computers are incapable of much more than simple one-voice melodies or beeps.

One of the more recent wonders of the computer age is the computer that talks. With recent advances in technology, computers can be made to talk in a variety of ways, and soon you'll see some exciting educational software that takes advantage of this capability.

Numbers, words, pictures, sound—these are just the beginning of the computer's talents in the output area. Not only can computers produce information for human consumption, they can also control other machines. With the right output devices, a computer can control a factory. In fact, a robot is nothing more than a computer with some fancy input and output capabilities.

Mass storage—RAM has two disadvantages for storing information: (1) it's a relatively expensive form of storage and (2) it develops amnesia when you turn off the power. It can never again remember what was once stored.

Some form of mass storage provides the solution to these two problems. The three most common media for mass storage today are the ordinary audio cassette tape, the floppy disk, and the hard disk. Cassette tapes are cheap, as are the cassette drives that permit the computer to write data onto them and read it back. Compared with other forms of mass storage, however, cassettes are terribly slow and inconvenient.

Floppy disk drives cost eight to ten times as much as cassette drives. But they're easily eight to ten times more reliable and convenient. Depending upon the system, the floppy disks used by the microcomputers in most classrooms today hold upward of 90,000 to 170,000 characters, that is 90 to 170K. This is enough to hold several sophisticated programs, or about all of the text in this book.

Hard disks are just beginning to find their way into the classroom. A hard disk drive, physically, is approximately the same size as a floppy disk drive, but it has two main differences. First, the disk, which is the physical medium upon which data and programs are recorded, is hermetically sealed inside the drive, whereas floppy disks can be inserted and removed. Second, hard disks hold much more data than floppies—anywhere from 5 million to 90 million bytes or, in the parlance, 5 to 90 megabytes, abbreviated 5 to 90M. As near as we can determine, a 5M hard disk will hold the entire King James Bible or its equivalent. If the Bible were stored on a hard disk, the central processor would be able to retrieve any passage in a few tenths of a second. The price of hard disk drives has tumbled dramatically in recent months, opening up exciting possibilities for educators.

So what good are computers?

Now we come to the question that interests you most. What good are these perplexing machines in the classroom. We propose five answers:

1. Computers are outstanding audio-visual aids for the presentation of ideas. They can present numbers, words, animated graphics, sound effects, music, and in some cases, speech.
2. Computers are outstanding tools to help youngsters explore and learn about abstract concepts. They're interactive. Youngsters can respond to stimuli and try out ideas. The computer provides near-instant feedback.
3. Computers can help lift the paperwork burden off teachers' backs. From keeping track of class grades to developing individualized educational plans, computers can help make teachers more efficient classroom managers.
4. Computers are vitally important in government, business, and private life, and thus deserve significant attention as topics for study in their own right.
5. Computers are amazing motivators. Most youngsters find learning with computers rewarding and fun. As do most teachers.

What Do We Mean by Computer Literacy

Computer literacy is one of the educational buzzwords of the decade. Unfortunately, the term means many things to many people.

Teacher/writer Daniel H. Watt gives a broad definition of the term. He defines it as ". . .that collection of skills, knowledge, understandings, values, and relationships that allows a person to function comfortably as a productive citizen in a computer-oriented society."

Dr. Watt goes on to divide the concept into four areas: (1) the ability to control and program a computer to achieve a variety of personal, academic, and professional goals; (2) the ability to use a variety of preprogrammed computer applications in personal, academic, and professional contexts; (3) the ability to understand the growing economic, social, and psychological impact of computers on individuals, on groups within our society, and on society as a whole; (4) the ability to make use of ideas from the world of computer programming and computer applications as part of an individual's collection of strategies for information retrieval, communication, and problem solving.

We would enlarge this concept even further to say that the computer literate individual needs sufficient knowledge to legally counteract (or at least to temper) computer applications that adversely impact his or her life or well being.

Computers are like fire. Used responsibly, they can improve our lives immeasurably. Misused, they can destroy things that we cherish, like personal liberty and privacy. Moreover, regardless of how scrupulously they're used, computers will change the ways in which we live, learn, and earn. In fact, these changes are already underway at a dismaying pace. It will take considerable wisdom to assure that these changes are constructive.

Computer literacy, then, is a point of view that must suffuse every aspect of the educational process, just as computers are, increasingly, suffusing every aspect of our culture. This means that we can't just inoculate our children with one shot of computer literacy and expect them to be literate for life. We must develop a coherent, comprehensive approach to computers that bears on every subject at every grade level. This may sound drastic, but the reason is simple: it's our obligation, as educators, to prepare our youngsters for tomorrow's world, and as the result of computers and their many uses, tomorrow's world will be dramatically different from today's.

Some questions

This is not to say that we must turn every youngster into a computer programmer. Nor is it to say that we must close down art or literature classes to make room for computer classes. It is to say that we must help our youngsters integrate computers into their lives in a constructive fashion. To do this we must grapple with some fundamental questions.

What significant choices, opportunities, and problems are our youngsters likely to face in their lives as the result of computer technologies?

What basic survival skills will they need?

What perspectives, values, and attitudes will help them confront these choices most appropriately?

What responsibilities does the larger society have toward people who are displaced by changing technologies?

What responsibilities do educators bear?

How can we best prepare our youngsters to preserve the best of the heritage that we have to pass along while adapting successfully to rapid social and technical change?

We feel that every teacher has something important to contribute toward these questions. Moreover, we feel that teachers trained in the arts, humanities, and social sciences have particularly important things to contribute. On the other hand, teachers who convey an irrational fear of computers, are misinformed, or ignore the increasing significance of computers in our society are doing their students a serious disservice.

Three stages

Computer literacy, in the sense proposed by Dr. Watt, moves through three stages: striving toward understanding, striving toward mastery, and striving toward control.

Striving toward understanding is the process through which the learner comes to understand how computers work and why they are useful. Most people don't need a detailed technical understanding of how computers work, but they do need to know enough to understand that computers are tools with limitations, not all-knowing, all-powerful creations possessing independent wills and minds. One youngster said, ''In the future, computers . . . will be like all the scientists in the world smushed into one.'' This belief is not only wrong, but it is frightening. It imples that computers will have omnipotent authority.

It is important for people to know that any information produced by a computer rests upon input data that may be wrong and upon a program that may be inappropriate or illogical. Further, the input data and the program are the responsibility of a human user. Consequently, every result produced by a computer should be rigorously questioned. Moreover, it is important that our youngsters recognize that scientists and computers process information quite differently. It may be valuable to explicitly contrast information about human creativity with information about how the computer works, to help youngsters gain a deeper sense of human versus computer potential.

Striving toward mastery is the process through which people learn how to use the computer as a tool. Only by mastering the computer in this sense does one fully appreciate its strengths and limitations. The term mastery may seem strong. But we define it in terms of the specific problems that an individual is likely to face in his or her own life. If one has a problem, one wants access to the best possible resources to solve it. Among other things, this means appropriate tools. Mastery implies that one has sufficient understanding to decide whether or not a given tool is appropriate in a particular situation and, if so, has sufficient skill to use that tool successfully. Mastery also implies that one has a wide selection of tools to bring to bear on different problems. Psychologist Robert Ornstein once said that ''if the only tool you have is a hammer, you tend to treat every problem like a nail.'' In other words, as well as knowing how and when to use a computer, mastery means knowing when *not* to use a computer and how to use the better alternative.

Striving toward control over computers and how they're used means striving toward freedom. On the personal level, this means attaining freedom of choice in how and when to use computers in one's life. It means gaining influence over how computers are used in one's work place. While one may not be able to veto the use of computers in the work place, one should not be forced to sacrifice one's health or human dignity for the sake of computerized efficiency. At the social level, striving toward control means developing a framework of ethics and laws that provides maximum freedom for the individual, while minimizing abuses.

Steps toward computer literacy

The first step toward computer literacy is simply to teach better many of the things that we now teach. It's doubtful that a person who is not literate in the classical sense can become computer literate as we've defined it. Moreover, the formidable challenges of the present and the future call for unprecedented imagination, creativity, and thinking skills on the part of the citizen.

The second step is for teachers and administrators to become computer literate themselves. This can be achieved through effective preservice and inservice training. But a teacher should not wait to get the ball rolling. At the end of this book we listed many resources for learning more about computers. You can learn a great deal through self-study, particularly if you can get your hands on a computer and start working with it. Expect some initial frustrations, but many long-term rewards. To help you along, create a brief outline for self-study. Include such topics as parts of a computer; programming; computer use in business, home, school; careers; related technology.

Concerted effort

While self-study is a beginning, it's doubtful that an individual teacher will get very far in bringing a comprehensive computer literacy program into a school or district without strong administrative support. But an individual can do a great deal toward winning that support.

Many districts with effective computer literacy programs started by setting up computer study committees. For example, the superintendent of the Brookline, Massachusetts, school system, which has a notable computer program, recruited a respresentative cross-section of teachers, administrators, parents, and community leaders for such a committee and set them to work under a strong chairperson. The superintendent gave the committee a well-defined mandate to develop a realistic policy and plan for integrating computers into the curriculum. The committee, working for more than a year, studied the literature on educational computing, listened to guest speakers, visited neighboring districts to study their computer programs, sent out a survey to districts across the country, and hashed out a strong statement of goals that, in turn, was developed into a detailed policy and five-year plan.

In short

Computer literacy is what it takes to enable people to use computers intelligently and creatively. It is not a substitute for conventional literacy but is, increasingly, important for individual and cultural survival. Computers are a transformative technology—even more so than steam or aviation. They are bringing fundamental change to the worlds of commerce, the arts, the sciences, communication, and education. They are even changing the way we spend our leisure time. Computers are reaching into every aspect of our lives, thrusting upon us both opportunities and challenges. Computers are forcing us to make important individual and social choices. They cannot be ignored.

Computer literacy is certainly a set of skills, but more. It is a way of thinking and a set of values. Computer literacy is not a subject that can be learned by rote in an hour or two, or even in a single course. It must be based upon and evolve out of the entire curriculum.

CHAPTER 3

Teaching with Computers

How does a child learn? Some educators believe in rigorous objectives and a step-by-step presentation of a well-structured curriculum. The emphasis is upon the techniques of teaching as opposed to the processes of learning.

Other educators believe that youngsters are motivated by an innate curiosity and will to learn, and literally construct their own knowledge out of the raw materials of their environment. Each child, say these proponents, has a unique internal blueprint for cognitive development. This blueprint determines what the child is able and willing to learn and when, and it gives the child a unique outlook and direction. These educators stress the importance of a learning environment that's rich with stimuli and possibilities for constructive feedback. They believe that each child should have considerable choice in what he or she learns and when.

Still other educators are pragmatists. They adopt from experience a variety of techniques that seem to stand the test of time.

The computer is such a versatile tool that all educators, regardless of their teaching approach, can use it effectively. The software programs available today reflect many approaches to pedagogy and many instructional philosophies. Here's a broad look at some of the types available.

Drill and practice

The underlying assumption of drill and practice is that some things just have to be learned the hard way—by rote memorization. And the fastest way to memorization is repetition and rehearsal. A typical drill-and-practice session designed to provide such repetition sounds something like this:

> “What's the capital of California?”
> “Stockton.”
> “Sorry, try again—“
> “Sacramento.”
> “Terrific. Now what's the capital of Connecticut?”

From a teacher's point of view, drill and practice is time consuming and tedious. Many youngsters would probably agree. Teachers often develop activities in which youngsters drill one another.

For the computer, drill and practice is trivial. Here’s a Basic program that will do it:

```
10 PRINT “WHAT’S THE CAPITAL OF CALIFORNA”;
20 INPUT A$
30 IF A$ = “SACRAMENTO” THEN 60
40 PRINT “SORRY, TRY AGAIN—“
50 GO TO 20
60 PRINT “TERRIFIC. NOW WHAT’S THE CAPITAL OF CONNECTICUT?”
```

This program is only a Tinkertoy, of course, but it demonstrates the essential idea. Line 10 tells the computer to print the question on the display screen. Line 20 tells the computer to print a question mark on the screen and wait until the pupil types in an answer. Line 20 also tells the computer to store the answer in an area of memory called A$. In line 30 the computer compares the pupil’s answer with the correct answer. If they match, it tells the computer to proceed to line 60. If not, the computer goes on to line 40 and prints the negative response. The computer then continues to line 50 where it is told to go back to line 20. At line 20, the computer again waits for the pupil’s answer.

Here’s a multiplication drill:

```
10 LET A = INT(10☆RND(1))
20 LET B = INT(10☆RND(1))
30 LET C = A ☆ B
40 PRINT “WHAT IS”; A; “TIMES”; B;
50 INPUT D
60 IF D = C THEN 90
70 PRINT “SORRY, TRY AGAIN.”
80 GOTO 40
90 PRINT “RIGHT!”
100 GOTO 10
```

Line 10 tells the computer to generate a random number between 0 and 9 and store it in memory location A. Line 20 tells the computer to generate another random number and store it in B. Line 30 tells the computer to multiply these two numbers together and store the result in memory location C. Line 40 asks the pupil for the product of these two numbers. Line 50 gets the pupil’s answer. Line 60 compares the pupil’s response with the right answer. If they match, it tells the computer to go to line 90. If not, the computer continues on to line 70, where it prints the negative response. Line 80 tells the computer to go back to line 40. Line 90 gives praise for the pupil’s correct answer, and line 100 tells the computer to start the whole process all over again. This program will generate multiplication problems until the cows come home, or at least until someone has the good sense to pull the plug.

Tutorial

Suppose we add line 5, as shown here, to the beginning of our states-and-capitals drill.

```
5 PRINT "THE CAPITAL OF CALIFORNIA IS SACRAMENTO"
```

Suddenly we've added an entirely new dimension to our drill-and-practice program. Now our program is essentially a tutorial in which we present the pupil with new information and then test his or her comprehension. The basic logical outline of a tutorial program looks like this:

1. Present concept
2. Test comprehension
3. If comprehension is demonstrated, branch to positive response
4. If not, branch to negative response

The theory of such tutorial programs is that we can dissect the most complicated subjects in the world into a sequence of simple concepts or ideas. If the learner demonstrates mastery of each concept in the proper sequence, we can rest assured that the pupil understands the topic as a whole.

The basic tutorial model can be embellished in many ways. We can use fancy animated graphics to present the concept. We can design elaborate procedures to validate our method of testing. We can provide review and remediation if the pupil answers incorrectly. Indeed, review and remediation can be another set of tutorial modules nested inside the original module like Chinese boxes. We can validate our positive responses to assure optimal reinforcement. We can program the computer to record right or wrong answers so that we can track the pupil's progress.

Elaborate tutorial systems spanning all grade levels and a remarkable range of subjects have been developed by the Computer Curriculum Corporation in California and Control Data Corporation in Minnesota, among others. These systems, which have been running on large computers for more than two decades, are usually what come to mind when people talk about computer-aided instruction, or CAI.

Games

In recent years, the coin-operated video game industry has generated more income than the movie industry—something over $8 billion a year, mostly from kids. Several educational publishers have developed software lines based upon these game formats. Three major formats have evolved.

Space invader-type games rest upon the fight-or-flee reflex. Usually it's kill or be killed; the player must shoot down an enemy before the enemy can shoot back. These games are fast, intensely involving, and require good hand-eye coordination, although many people question the underlying martial assumptions.

Perhaps the best example of the genre is a typing tutor called *Master Type*. The player's spacecraft occupies the center of the screen. Enemy vessels enter the screen from each of the four corners. The player can annihilate the enemy vessels by successfully typing a sequence of alphabetic characters that appears in the center of his or her spacecraft. These characters, of course, are carefully selected by the computer to help improve the player's typing speed and accuracy.

The success of Pac Man has spawned a host of games based upon mazes. As an example of a maze game, the authors developed a vocabulary game for Reader's Digest called *The Chambers of Vocab*. In the game, four vocabulary words slither like beasts through a maze. To escape the maze, the player has to "conquer" all four beasts, that is, match each word with the correct definition against time pressure. To do so, the player must seek out the correct work in the maze while avoiding the incorrect words. The way the words move through the maze compels the player to focus upon letter combinations within the words.

A third popular format is based upon a game called *Adventure* which originally gained popularity on large university computers nearly 10 years ago. The object of an adventure game is to search for treasure in a labyrinth of caves or rooms while, at the same time, avoiding various hazards. Adventure games call upon the player's logical faculties and memory. Some require the player to buy provisions, hire soldiers, keep careful account of the various magical powers wielded by adversaries, and so on.

Tom Snyder of the Learning Connection in Boston has transformed this adventure format into games appropriate for the classroom. Called *The Search Series* (McGraw-Hill), they are designed to be played by competing groups. The series, which includes *Geography Search, Geology Search, Community Search, Energy Search,* and *Archeology Search,* promotes critical thinking skills while teaching social studies and science concepts.

Games offer two major educational benefits. A well-designed game sharpens the player's concentration and problem-solving skills. Moreover, games can help the teacher present difficult or tedious material in an interesting way. Some of the best games offer still a third benefit—they provide concrete metaphors for thinking about more abstract problems.

Here is a program for a simple game called *Hi-Low:*

```
10 LET X = INT(100 ☆ RND(1) + 1)
20 PRINT “I'M THINKING OF A NUMBER BETWEEN 1 AND 100.”
25 PRINT “WHAT IS YOUR GUESS”;
30 INPUT A
40 IF A < X THEN PRINT “TOO LOW”
50 IF A > X THEN PRINT “TOO HIGH”
60 IF A = X THEN 80
70 GOTO 25
80 PRINT “YOU GOT IT! HOW DID YOU GUESS?”
```

Line 10 tells the computer to generate a random number between 1 and 100 and store it in a memory location called X. Lines 20 and 25 print the instructions to the game on the display screen. Line 30 prints the question mark on the display screen right after the word “GUESS” and then waits for the player to type in a number. The computer then stores the player's number in a memory location called A. Lines 40 through 50 compare the player's guess with the number picked by the computer. If the guess is too low, line 40 tells the computer to print “TOO LOW.” If the guess is too high, line 50 tells the computer to print “TOO HIGH.” If the guess is correct, line 60 tells the computer to jump down to line 80. Otherwise, the computer continues to line 70, which tells the computer to go back to line 25. By now, the purpose of line 80 should be obvious.

Simulations

What better way to teach a youngster about nuclear power than by putting him or her in charge of a nuclear reactor? *Three Mile Island* (Muse Software) simulates in elaborate detail the operation of an actual reactor. The user controls the reactor, trying to make maximum profit while avoiding meltdown.

A computer simulation is a program that emulates the logic of a physical or social system. As long as a system can be described mathematically, it

can be simulated on a computer. Computer simulations are invaluable problem-solving tools in business, government, and science. They are also outstanding teaching tools. Here's a short program, for example, that simulates the toss of a coin:

```
10 LET X = INT(2 * RND(1) + 1)
20 IF X = 1 THEN PRINT "HEADS"
30 IF X = 2 THEN PRINT "TAILS"
```

Line 10 tells the computer to generate a random number between 1 and 2. Line 20 tells the computer to print "heads" on the screen if the number is 1. If the number is 2, line 30 tells the computer to print "tails." Running the program is like flipping the coin once. This little program could form the foundation for a game, or for an entire unit on probability or statistics.

A wide range of simulations appropriate for the science and social science classroom are on the market. Edu-Ware Services, Inc. offers *Rendezvous*, which simulates an actual space shuttle flight, including lift-off, orbital rendezvous, approach, alignment, and docking. Science Software, Inc. has a program that simulates the behavior of active and dormant volcanoes. Various social studies simulations allow the student to explore topics as varied as presidential politics, energy policy, corporate management, population growth, and the diffusion of innovation.

Computer simulations allow the learner to change some variables and observe the consequences. They allow the learner to experiment with systems that are inaccessible because they are too large, too dangerous, too expensive, too time consuming, or otherwise not available for direct experimentation.

Learning tools

Given the right software, computers are outstanding tools for creative expression.

Word processing software, for instance, can take the drudgery out of writing. As every professional writer knows, rewriting is an essential part of the writing process. But for many youngsters, the tedium of hand copying a composition undermines the benefits of rewriting. On the other hand, making editorial changes in a composition is both easy and fun with a word processor. Moreover, once the composition is stored in the computer, the writer can print out copies for the class. Writing thus becomes a publishing process, and the writer gains both peer recognition and better feedback.

Similar benefits are available from software that enables the user to create pictures and designs on the computer's display screen. Reston Publishing Co., for instance, has a program called *Paint* which enables students to create paintings on the screen and save them on disk for later display. As a medium of artistic expression, the computer emphasizes aesthetic and compositional skills over the fine motor skills that many other media require.

Further, it's becoming an increasingly well-known fact that computers are outstanding instruments for creating music. *Music Maker* (Texas Instruments) is a music composition module that lets the user arrange notes on an electronic musical staff. Thus, the user can see and hear at the same time. *Music Skills Trainer* (also Texas Instruments) provides four drills—pitch guess, interval recognition, chord recognition, and phrase recall. This program tests musical ability and reinforces skills. En-Joy Computer Programs has a program called *Banjo Teacher* which uses graphic displays of 118 chords to teach the banjo. The user can add, delete, or change the chords and alter the timing. They have similar programs for guitar, mandolin, and ukulele.

Problem solving

Many educators feel that using the computer as a tool for teaching problem solving is probably the single most valuable educational application of all. Several approaches are possible. One company, for instance, has a series of disks that teach specific problem-solving skills. But many educators feel that learning how to program the computer is, in itself, an outstanding context in which to learn general problem-solving strategies.

A variety of programs are offered to help teach programming. Sterling Swift, for instance, offers *How to Program in BASIC*, a set of tutorials on disk which tie in to the publisher's book, *Hands On Microcomputer Workbook*. McGraw-Hill offers a seven-disk package called *Computer Power: A First Course in Using the Computer*. This package teaches Pascal, an important computer language.

MIT professor Seymour Papert is critical of most conventional computer languages as educational vehicles. They are too clumsy to work with and too abstract for youngsters, says Papert, who studied with developmental psychologist Jean Piaget. Working with others, Papert helped develop a language called Logo, which was expressly designed for education.

Logo provides a small set of intuitively obvious commands. In the graphics mode, for instance, ''Forward 10'' tells the cursor, a small illuminated triangle that marks the center of focus on the screen, to move foward 10 units. In Logoese, the cursor is called a turtle. ''Right 90'' tells the turtle to turn 90 degrees to the right. If given the command ''Forward 10'' once again, the turtle would move 10 units in this new direction. Proceeding in this manner, the programmer could make the turtle trace the perimeter of a square. If the command ''pendown'' is given at the beginning, the turtle will actually draw the square as it moves.

All of the commands necessary to create the square can be combined into a procedure, or short program, and given a name such as ''box.'' From this point on, ''box'' becomes a command in the language. Whenever the programmer commands ''box,'' the turtle will draw the box. The advantage of this feature is that youngsters can develop the solution to a problem in their own language.

Working in the graphics mode of Logo, youngsters can see immediately the consequence of their logic. Logo makes it easy for youngsters to correct, or debug, their logic when the result is not what they want. Moreover, Logo encourages youngsters to break large problems down into small parts, try tentative solutions and debug them when they don't work, and use familiar metaphors to try to understand an unfamiliar problem.

Reviewing and Purchasing

Educators usually bring computers into their schools to solve specific problems—remediation, enrichment, parental demands for computer literacy. But then they realize that computers are more useful than they had imagined. They see applications in every subject, as well as in administration and instructional management. They also discover the hundreds of plug-ins, add-on gadgets that promise to transform their simple, friendly little microcomputers into powerhouses of electronic capability.

The resulting intoxication—as exciting as first courtship and as potentially painful—can lead to unwise purchases, ruptured budgets, frustration, disillusionment, and more. There's no doubt that computers are exciting and important innovations in education, but their successful use requires hardheadedness—research, analysis, planning, management. It requires skillful orchestration of vision, hardware, software, facilities, supplies, people, and administrative procedures.

Before you buy hardware, decide what you want to accomplish—raise test scores, enhance problem-solving skills, prepare youngsters for the job market? You also need a reasonable understanding of how computers will help you accomplish these goals—drill and practice, games, simulations, programming?

Then there are logistic questions. At what grade level will the computers be introduced and in what subjects? How many youngsters will need to use the computers, how often, where, and for how long at a sitting? How will you train the teachers and students to use the computers? How will you provide for continuity from one grade level to the next? And finally, what special constraints must you deal with before you can introduce computers into your classroom, school, or district—economics, building security, union rules, parental attitudes? A carefully chosen and well-informed committee can be invaluable in helping resolve these issues.

Hardware

A good rule is to find software that does what you need and then have the vendor tell you what kind of equipment you need to support the software.

This is somewhat easier to say than to do, but it will simplify your hardware selection considerably.

A second rule is to consider the whole system and not just the component pieces. An educational computing system is made up of people and machines. People include students, teachers, administrators, support personnel, and perhaps even the community at large. The machine must respond to the people and serve their specific limitations and needs.

Every computer system must provide a way for users to enter data and programs (*input*), provide adequate storage for their data and programs (*memory*), process their data appropriately (*central processor* under direction of proper software), and be able to communicate results in an easy-to-use and appropriate form (*output*). The specific hardware components that perform these functions can be simple or complicated, inexpensive or costly. Generally, the greater the demands that people put on the machines, the more complicated and costly the hardware needs to be to meet the challenge. But when you assemble a complicated system, you must beware of hidden ''gotchas''—components that don't work together, more complicated operation, greater maintenance problems.

Here are a few questions to consider before you specify equipment:

- What kind of data will users want to enter into the computer and what is the most efficient way for them to do it? An answer here will help you evaluate keyboards and other input devices.
- How much data and what size programs will users want to run? This will tell you how much memory your computer must have. Speaking of memory, it's important to consider both the amount of memory in the computer itself (Random Access Memory) and mass storage capacity of the system (cassette or disk storage).
- Some computers provide only uppercase video character display and others provide both upper- and lowercase. Is this important? What about graphics? Are they necessary? Is color important? How much resolution do you need? Do you need fast animation or other special features?
- Except for the simplest of setups, your computer system will certainly need a printer. But how fast does it need to be? And how rugged? Do you need letter quality or special fonts? Is noise a factor?
- Do you want to connect your computers into a communication network—either within the school or across the country—so that you can exchange programs and data?
- What about security and maintenance? How will you provide them?

A good way to answer these complicated questions is to define your educational mission and then talk with several reputable dealers who can help you design a package. Give them your detailed performance criteria and let them recommend specific choices. Request bids and negotiate a clause in the final contract that says that the dealer will bear responsibility if the system doesn't meet your explicitly stated needs. You may pay more in the beginning, but you're more likely to save in the end. A good vendor will help you with selection, initial setup, inservice training, maintenance, and upgrading.

Request and study the manufacturers' literature. Read reviews in the computing magazines. Try the machines at dealers' showrooms and at conventions. And don't buy without a demonstration.

Software

Two questions pop up whenever educators talk about software—"What's available?" and "Is it any good?"

The first question is easy. There are more than 2,000 education programs on the market today.

The second question is another matter. It depends upon your philosophy of education and what you feel about computers. To a large degree, quality is in the eye of the beholder. We feel that the best person to judge software is the classroom teacher who will use it. Properly used, computers are tools that extend the capabilities of the teacher. Just as a carpenter works best with familiar and comfortable tools, so does a teacher.

Unfortunately, many good teachers are still intimidated by computers. They tend to suspend the keen professional judgment they would apply to a new textbook, learning kit, or film. The truth is that the computer is simply another medium; it has its strengths and weaknesses, its proper and improper uses. The first recommendation we would make about software evaluation is to forget about the mystique of the computer. Bring to the task your judgment and competence as an educator. That done, you should ask three basic questions:

1. Does the program fit the needs of your curriculum? Is it appropriate from the point of view of subject matter and grade level?
2. Is the software educationally sound? Does it help establish or support an effective and affirmative learning experience for the user?
3. Is it easy to use? Does it work as it is supposed to? Are the manuals easy to read and comprehensive? Can the teacher and student use the software with minimal frustration and extraneous effort?

Each of these larger questions, of course, encompasses a multitude of smaller questions. But they're the same questions asked when evaluating other educational materials.

This leaves one small problem. How do you get to see software that you want to evaluate? While reviews of software can guide you in the right direction, there's no substitute for seeing with your own eyes. The sad fact is that many vendors are reluctant to send out free review packages—they've been burned too many times by pirates. Publishers have found that piracy (unauthorized copying and distribution of copyrighted software) is a major problem. Ironically, the pirates are otherwise well-meaning educators who would be outraged if they caught their own students stealing. Somehow they have not equated unauthorized copying and sharing with stealing. Because of this problem, software prices are higher than they need be and many major publishers have chosen to limit their investment in software development and marketing.

But there are ways you can preview a wide selection of software. Providing that geography is not a problem, distributors will demonstrate software if you ask, either on your premises or theirs. Educational computing conferences also provide outstanding opportunities to see the latest releases. Visiting other schools and districts is still another way to broaden your exposure. And many teacher centers, colleges, universities, and regional educational collaboratives are building up software libraries. If your school or district doesn't belong to a regional educational computing collaborative, we suggest that it join. The rewards will far outweigh the effort.

Clearly, it's well worthwhile to preview as broad a range of software as you can. The more you've seen, the better your ability to discriminate.

Where to buy?

The wide selection and remarkable modularity of small computers are wonderful but you must be knowledgeable before you fill out a purchase order. All the components in the system must fit together like pieces of a jigsaw puzzle. The disk drives and printers need to talk to the computers; the software must fit the disk drives and run properly with the rest of the system. If you buy a conventional system from one manufacturer you'll have little problem. But if you want special capabilities such as speech synthesis or special graphics features, you'll find a frustrating lack of standards in the industry.

Then there's the matter of price. The store down the street quotes you one figure and the mail-order dealer another. The educational computing distributor offers a complete package; if you mix and match from several sources you may come out with a better price.

This leads to a basic question—with whom should you do business? The manufacturers? The mail-order discount houses? The educational distributors? Your local computer store? Let's look at the options.

Manufacturers. If you're buying a large number of computers—a purchase for the district, for instance—it's well worthwhile to prepare a request for bids that includes detailed specifications of your needs; send it to the national accounts sales office of each of the major microcomputer manufacturers. If you're talking large numbers—several hundred computers, for example—you can often negotiate favorable prices on hardware and software and get extras such as teacher training and long-term maintenance included in the package. Since you'll get the best response from manufacturers who are trying to advance their competitive position in the education market, this approach works best if you do your homework on products and prices and do not have a strong preference for a particular make.

Mail order. Unless your school is in the north woods, the only reason to consider buying through a mail-order house is lower prices. The many mail-order outfits advertising in the computer magazines show prices often 30 percent or more off list. But you should consider buying through a mail-order firm only if you know exactly what you want, will not need help installing or using it, and have a reliable arrangement for service. Check the reputation of the mail-order house for reliability before you buy. When you place an order through the mail, avoid paying cash in advance and be willing to cancel if you don't receive prompt delivery.

Educational distributors. The educational distributor who offers computer products will speak your language, whereas many other people in the computer distribution chain won't. The educational dealer will stock hardware and software that is specifically selected to meet the needs of schools, will keep up with which districts are doing what with computers in the area, and will often offer inservice training.

Sales personnel will usually be helpful with information and suggestions before you buy and will be attentive to problems after. You'll usually pay full list price for this service, but to many educators it's worth it. The major disadvantage of buying from an educational distributor is evident if you are geographically distant from its nearest office. It's hard to get good service from a firm that's 100 or more miles away.

Computer stores. Computer stores and other retail computer outlets are nearly as common as pet stores. Some cater to hobbyists and some to business. Some are little more than counters at the back of an appliance stores, and some are slick, interior-designed national franchises.

Buying from a local computer store has one major advantage. Since, as an educator, you are an influential and visible person in your community, the management of the local computer store has a vested interest in keeping you happy. Prices will generally be higher in a computer store than elsewhere, but so is the willingness to provide information and service. Such willingness, however, depends upon the quality of the local management.

One way not to be appreciated in your local computer store is to take up a considerable amount of time and effort while you collect information and prepare your specifications, but then place your order through a cheaper source. If you come back to the store looking for installation, application, or service information on the products you bought elsewhere, don't be surprised if they cold-shoulder you out the front door.

The bottom line is this: if you know what you're doing, shop widely and drive a hard bargain on price. If not, buy from someone local and look for the best support and service.

Computer-Managed Instruction

You've probably heard the term computer-managed instruction (CMI), but what does it mean to you? How about easier test preparation? Simplified record keeping? More time for teaching and less time on paperwork? A computer in your classroom can bring you these benefits and more.

Many drill-and-practice, tutorial, and game programs offered by educational publishers come with management systems. To use these systems, typically, you first type the names of your students into the computer. Then, as each student works through the program, the computer automatically keeps track of his or her progress, recording units completed and test scores. Some systems will even guide the student through an appropriate sequence of instructional units based upon the student's responses to test items. At any time you can look at the file, although often you must first type in a secret password to get access. (This reduces the possibility of students breaking into the management system and, perhaps, altering records.) Usually you can examine records on either the video display screen or printed out as hard copy. You can check up on a given student or review the progress of the entire class. Some of the better systems even calculate class averages and other useful statistics.

Computerized testing

Creating, administering, and scoring tests is time consuming and tedious. Test-writing software makes the job easier. Most such systems let you choose one of several basic test formats, including question and answer, true/false, and multiple choice. You determine the number of items in the test, the material to be covered, the level of difficulty, and the point value of each item. Some systems come with a bank of prewritten test items. Others require that you add your own items. In either case, it's usually quite easy to add, delete, or modify items. Some systems print out the test as hard copy, others present it interactively on the computer itself, and still others offer both options.

Delivering the test on the computer itself offers several advantages. When the student makes a mistake, the computer can present additional items in that area. From the teacher's point of view, this provides more insight into the limits of the student's knowledge, while from the student's point of view, it provides more practice. An additional advantage of administering the test by computer is that each student can arrange his or her own time to take the test, or to repeat it as needed. Moreover, the computer can automatically score the test. Here are some examples of commercial test-generating systems:

MicroTest (Chariot Software) helps the user create, edit, and update his or her own test files or files provided by the publisher. The user can select test questions and level of difficulty.

Multiple Choice Files (Comput-Tations, Inc.) allows the user to create, save, and retrieve multiple choice tests. It provides up to five choices for each question.

T.E.S.T. (TYC Software) allows the user to create true/false, multiple choice, and completion questions for use as review or scored tests. User can print out both the test and the answer key on the printer.

In addition to helping you generate tests, computers can also help you analyze the results. When you enter test scores into *Exam Analysis System* (Microphys Programs), you get back a statistical summary that includes the mean and standard deviation, as well as an item analysis. *Inter-Stat* (Serendipity Systems, Inc.) goes one step further. It helps you apply a whole set of inferential procedures such as the T-test, Mann-Whitney U-test, Chi-square contingency test, regression and correlation.

Related to the test analysis programs are various programs that help you determine the reading level of test items and other materials that you may wish to give to your students. The *Fry Readability Formula* (Jamestown Publishers), for instance, helps you apply the Fry readability formula to text passages. *Readability Index* (Educational Activities, Inc.) uses the Bormuth Formula. *Readability* (Micro Power and Light Co.) provides you with nine different formulas for measuring readability, including the Dale-Chall, Flesch, and Holmquist tests. Moreover, it displays results graphically.

Several simple test-generating programs recently have been published in magazines. If you don't count the time that it takes to type them into the computer, these are free to the user. Check indexes of back issues for some of these programs.

Authoring systems

Authoring systems help you create entire lessons. *GENIS* (Bell & Howell), for instance, is a complete curriculum development package that enables the nonprogrammer to create computer-based lessons. Typical lessons present information, ask questions, and process the responses. *Mathword* (Apple for the Teacher) is an authoring system specifically for math. It helps you create lessons that provide logic, thinking skill, and word problem practice. *Tic Tac Show* (Computer-Advanced Ideas, Inc.) lets the nonprogrammer create multiplayer games that simulate TV game show formats.

Comprehensive management systems

Comprehensive management systems integrate testing, analysis, prescription, and record-keeping functions. Some packages such as *CLASS—Computerized Learning and Scoring System* (Holt, Rinehart and Winston) key into existing basal series, in this case the Holt basal math and reading series. The system provides tests, which it automatically scores, and, based upon the test results, prescribes remedial lessons from the texts. It also maintains a record of each student's progress, providing the teacher with 14 different reports.

Mathematics Assessment/Prescriptive Edu-Disks (Reader's Digest Services, Inc.) is keyed to nine specific basal series. An eight-disk system, the diagnostic/prescriptive system package measures seven proficiency levels. It includes tutorials, post-tests, and a management system that will maintain records for up to 100 students.

The Institute for Applied Human Resources offers a computerized instructional management system based on the mastery learning approach to instruction.

Zweig Associates and Skillcorp Publishers, Inc. offer a computerized management system in reading and math that includes over 1,000 diagnostic/prescriptive tests keyed to behavioral objectives and correlated with major basal programs. Tests are scored by a special computer add-on called the Zweig Mark Reader. The system provides printouts and compiles performance records.

These are only a few of the many systems available.

Other management tools

A broad variety of software products will help you cope with information overflow. These range from general-purpose database management programs to specific programs for storing and retrieving information about grades, attendance, or resource materials.

A database management program such as *VisiDex* (VisiCorp) or *Dbase II* (Ashton-Tate) transforms your computer into an intelligent file cabinet. To use a database management program you organize your information into files. Each file is made up of a number of records. Each record is made up of a number of fields. Name, address, city, state, and zip code are examples of fields that might make up a record in a mailing list file. The database management program makes it easy to find a given record; add, delete, or modify records; sort records; or print them out. Usually, database management programs require little or no programming ability.

More specific data management programs are set up for specific types of information. *Grader* (Micrograms, Inc.), for instance, not only helps you maintain your grades, it averages letter or numerical grades. *Grade Book* (Edu-Soft, Steketee Educational Software) maintains grade records, allowing you to enter and change class lists, enter marks for students in three formats, compute averages and curves, and print out reports.

SuperPlanner (Learning Tools, Inc.) is a three-part software system for maintaining administrative files and student records, and for organizing instructional resources such as films, textbooks, and staff. It's useful for individualized instruction planning and maintaining I.E.P.'s.

Advice (Integrated Futures) is an information system in which the teacher can store advice about remedial help by objective or concept. The student can then query the computer for advice when stuck on a question.

E.P.I. Management System allows you to access over 5,000 materials from hundreds of publishers. You can sort materials by skill area, format, grade level, modality, teacher-learner interaction, and five other characteristics. You can even customize the system to fit your own needs.

Project I.E.P. (Evans Newton, Inc.) creates, monitors, and evaluates student I.E.P.'s based on P.L. 94-142 regulations and on your school district's own special education program objectives.

Word processors

No discussion of computer-managed instruction would be complete without mention of word processing. A word processing program turns the computer into an intelligent typewriter. To use it you first type your lesson, letter, report, or great American novel on the computer's keyboard. As you type, the computer displays your text on the video screen and enters it into memory. Now you can correct mistakes; insert letters, words, or paragraphs; move blocks of text around; search for specific references in the text; and so on. Each change that you make updates the text file in the computer's memory. At any time you can print out the text. If there's a mistake, fix it on the computer and command the computer to print out another draft. Never again do you have to retype pages of copy to fix a small mistake somewhere near the beginning.

Even inexpensive computer printers churn out text 10 to 20 times faster than an experienced typist. If the text is long enough, you can go out and have a cup of coffee while it's printing. Moreover, you can store your text on a floppy disc. This means that six months later you can print out another copy if needed.

Here are some things that you can do with a word processor to make your job easier:

1. Maintain your reading list and update it as needed.
2. Store anecdotal notes on students.
3. Maintain your tests.
4. Keep your lesson plans current.
5. Keep a series of paragraphs to cover a wide range of situations in its memory. You can write individualized notes to parents by selecting and modifying appropriate paragraphs.
6. Maintain mailing lists.
7. Keep your curriculum vitae up-to-date.

CHAPTER 6

Computer-Related Curriculum Ideas

Now that you have the low-down on computers and what they can do for you, let's look at how you can build curriculum around specific pieces of educational software. Whether you're teaching verb inflections or the Westward Movement, chances are a computer program can help you do it. What's more, the programs themselves generate further class activities.

One final note. We are indebted to the Microcomputer Division of the J. L. Hammett Company, an educational distributor, for providing some of these ideas.

Computer literacy

1. Before starting a programming unit with one of the *I Speak BASIC* texts (Apple, TRS-80, and PET versions are available from Hayden Publishing), introduce the concept of programming with the following robot exercise. Tell your students that you have a robot who obeys a few primitive commands. These include: stand, take one step, raise arms, extend hand, and *turn*. Students must sequence these commands to make the robot stand up and walk to the wall, stop at the wall, turn around, walk back, and sit down. One student plays the robot, moving only as classmate instruct. Adjust the complexity of commands and tasks to the class's ability level. Grades 4 and up.

2. Children can use *Delta Drawing* (Spinnaker Software) or LOGO (various producers, including Terrapin, Inc. and Krell Software Corporation) to create a class mural. The class can determine the theme of the mural and assign sections to groups of students. Alternatively, each children can contribute his or her own idea. Requires a printer. Grades 3-7.

3. One way to help students understand how a computer works is to have them simulate one themselves. Webster/McGraw-Hill's *Introduction to Microcomputers* uses six games to introduce the computer. After students have worked with the program, volunteers represent the parts of a computer—

keyboard, CPU, monitor, memory, disk drive, and so on. Another student has a card with information on it. The class must decide where the card should go for the information to be properly processed. Grades 3 and up.

4. *Computer Discovery* (Science Research Associates) provides a complete computer literacy curriculum. Make this curriculum come alive through field trips to local businesses using computers. Organize class trips or assign individual students to research local businesses and how they're using computers. Have students see how many computer-using businesses they can find in a five-block business area. Grades 6-8.

Language arts

5. Once all students have used an antonym review program such as Hartley Software's *Opposites,* have them play this variation of charades. After the players have missed several opportunities to guess the word, the student giving the clues writes the word's opposite on the board. This activity is appropriate for both whole-class and small-group activity. Grades 3-8.

6. Have your students review prefixes and suffixes with a program such as *Vocabulary—Prefixes/Suffixes* (Milton Bradley). Then have them create packs of prefix, suffix, and root word cards with which to play the following card game. In turn, each student turns over one card from each pack. If a root word and prefix or suffix match, the player gets one point—providing he or she can define the new word. If one or no cards match, the player holds the unmatched cards until the next turn. The student with the most points when the cards have all been picked up wins. Grades 2-8.

7. After using *Story Builder/Word Master* (PDI), students use the new nouns, verbs, and adjectives they've learned in stories of their own creation. They count the number of new words they use in each essay and note them on a personal progress chart. The goal is 100 new words. Grades 4-8.

8. Use Reader's Digest's *Key Lingo* vocabulary game to stretch students' imaginations and hone their writing skills. *Key Lingo* casts a student as a word trader plying the Sea of Words. After students have played the game, have them create their own island worlds in the form of illustrated story books or board games. Encourage them to use the vocabulary they learned playing *Key Lingo*. Grades 5 and up.

9. Get triple duty out of a word processing program such as *The Bank Street Writer* (Scholastic Software). As children learn to use this important tool, they practice writing and editing skills. For an added bonus have them bone up on new curriculum materials. Students pair off, with each pair responsible for researching one aspect of a science or social studies topic. In turn, each pair enters a paragraph of information into the word processor. Each successive pair must integrate its new information so that the final essay reads as if one student wrote it. Grades 4 and up.

10. Use Bertamax's *Spelling in Context* program to build vocabulary as well as spelling skills. This fill-in-the-blank program asks students to

correctly spell the missing word. But students can as easily take the words they've learned and create new sentences for them, demonstrating their knowledge of the word's meaning as well as of its spelling.

11. Fill those extra minutes before the bell rings with word search puzzles created with *Word Search Puzzle Maker* (Computer's Voice). You can create puzzles with any vocabulary you choose, or have students make puzzles for one another. Puzzles can be from 10 × 10 to 40 × 40 characters. You'll need a printer. Grades 1 and up.

Mathematics

12. Three DLM math programs. *Alien Addition, Minus Mission,* and *Meteor Multiplication,* use a space theme. Use this theme to create a bulletin board learning center. Assign one student a day to write three multiplication, addition, and subtraction problems on the space bulletin board. The student who solves the problems first provides the problems for the next day. Or each student could have a rocket ship that advances toward its star-base destination each time he or she gets a correct answer. Grades 1-6.

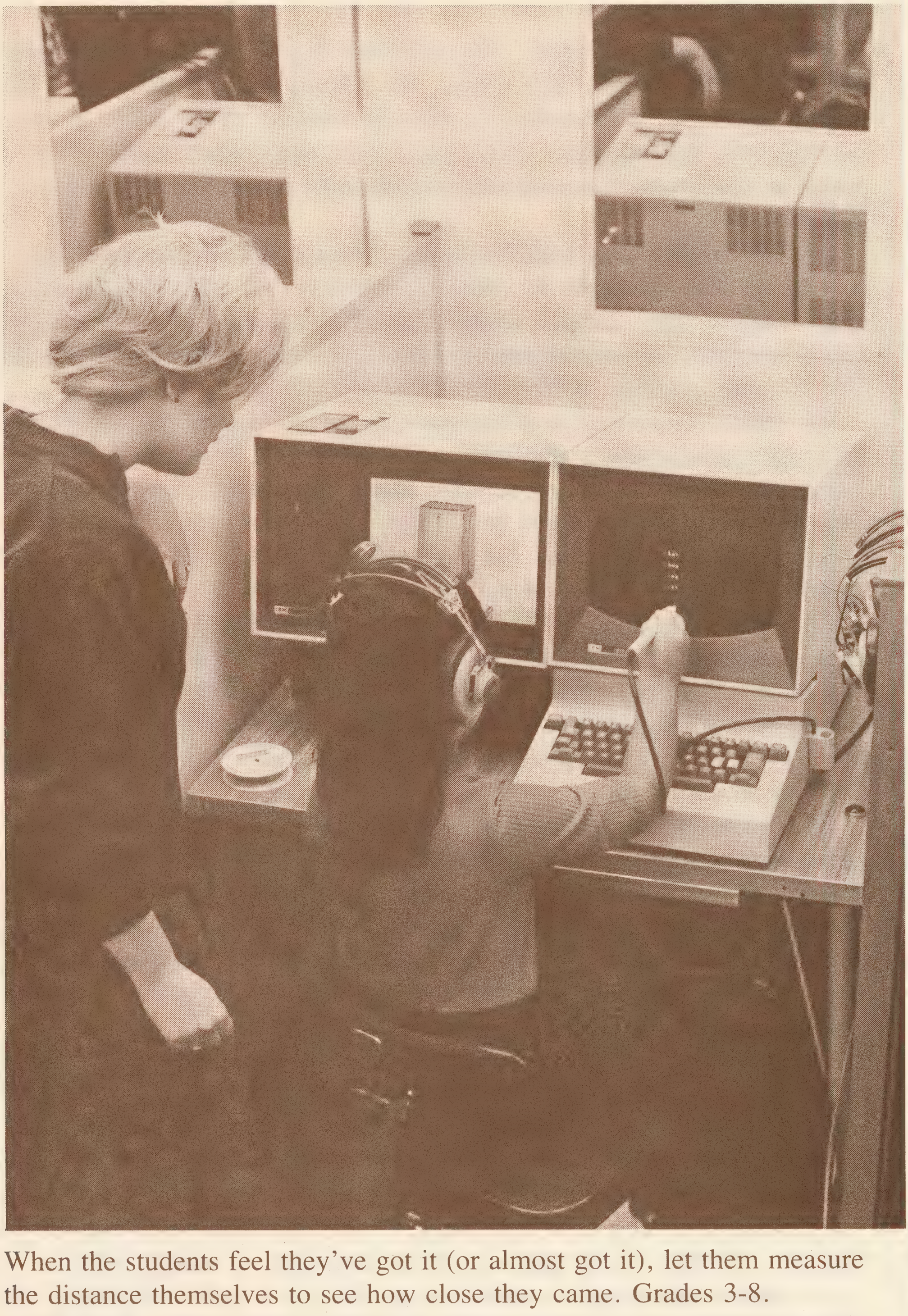
13. As a follow-up activity to Hartley Software's *Metric Drill* program, have students measure their classroom and the objects in it in metrics. Groups of students can label areas with appropriate metric measurements. Grades 4-8.

14. After children learn about graphing from a program such as *Bumble Plot* (The Learning Company), have them plot things in the world around them: students' heights; the number of classroom books with red, blue, or green binding; daily temperature for a week. Let students suggest things to plot. Grades 3-8.

15. Turn math speed drills into a classroom ''Math Meet.'' Students prepare for the meet with the *Speed Drill* program on *Elementary, Volume 1, Math* (MECC). On the day of the meet, bring to class a stopwatch and a set of large arithmetic flash cards. Divide the class into two teams. Successive players on each team have five seconds each to solve a problem correctly. The team that gets the problem right first gets the point. If a player calls out the wrong answer, he or she forfeits the point to the other team. The team with the most points wins. Grades 1-6.

16. One of the skills taught in *Creative Play: Problem Solving Activities with the Computer* (Math and Computer Education Project) is pattern identification. Have children who have worked with this program create their own pattern puzzles. Children switch puzzles and try to sequence one another's handiwork. Grades 3-6.

17. *Guess the Number* (Edu-Soft Steketee Educational Software) challenges estimating skills. Measure various distances in your classroom, then put students' estimating skills to the test. How far is the door from the window? The first row from the third? The computer from the bookcase? Let children guess, and tell them whether they're too high or too low in their estimations.



When the students feel they've got it (or almost got it), let them measure the distance themselves to see how close they came. Grades 3-8.

18. Have your students follow a session with *Naming Numbers* (Micrograms, Inc.) with a simple matching activity. Make up two sets of cards, one with the numerals 1-30 and the other with the corresponding number words. Have a student lay out half of each set. He or she then has a minute to match as many cards as possible. Successive tries should yield successively higher scores. Grades K-2.

Science

19. The program *Classify: Classification Keys for Living Organisms* (Diversified Educational Enterprises, Inc.) helps students understand the underlying logic of classification keys in biology. After students have worked with this program, divide them into teams. Each team creates a world of imaginative flora and fauna which another team will try to classify. Grades 7 and up.

20. Let children play with *Volcanoes* (Science Software Systems, Inc.) a program that simulates the behavior of active and dormant volcanoes. Then suggest they research another powerful natural force. Have them report on what they would need to know to create a computer simulation of a tornado, a geiser, a hurricane. Grades 7 and up.

21. Many versions exist of the game *Lunar Lander,* in which a player must successfully land a spacecraft on the surface of the moon. Make this game the basis of a learning activity. Have your students gather as much information as they can about the surface of the moon, pointing out places where landing would be too dangerous, where would it be safest, easiest to land, and so on. Grades 4 and up.

22. Cross Education Software's *Dinosaurs* teaches youngsters about these ancestors of the birds. Create a dinosaur ''museum'' in your classroom. Have each child draw or model his or her favorite dinosaur. Each specimen should be accompanied by a fact sheet telling when and where the dinosaur lived, what it ate, what beasts were its enemies, and why it is the student's favorite. Grades 1-6.

23. Create an astronomy unit around the *TellStar I and II* programs (information Unlimited Software, Inc.). Divide the class into groups. Each group observes the sky one night a week for a month. The groups collect information about the location of stars and then use the TellStar software to make identifications. The groups can then prepare illustrated reports on their findings. When put together, these reports should provide a detailed portrait of your local nighttime sky. Grades 7 and up.

24. *Nutrition—A Balanced Diet* (Science Software Systems, Inc.) and *What's in Your Lunch?* (Math and Computer Education Project) both analyze the nutritional value of foods. Have students check the nutritional value of their lunches. The one with the highest nutritional value gets an apple from the teacher. Alternatively, have students track what they eat for a week. After analyzing their diets, suggest they eat a menu for the following week that would correct any nutritional imbalance. Grades 4 and up.

25. *Heart Lab* (Educational Activities, Inc.) uses animated graphics to simulate a functioning human heart. Similarly, Brain Box's *The Human Body: An Overview* uses animated graphics to illustrate text about the systems of the human body. Students can follow a session with either of these programs with survey of heartlike devices in their world. What pumping devices can they locate? How do these differ from and how are they similar to the human heart?

26. The program *Odell Lake in Middle School, Volume 3, Science* (MECC) introduces students to the concept of food chains. Have students explore another type of food chain, perhaps the food chain in a forest or a tide pool, as a follow-up activity. Each researches one facet of the food chain, then the class makes a master chart of the information it has found. Grades 6-9.

Social studies

27. Using the same format as *Community Search* in the *Search Series* (McGraw-Hill), have groups of students explore their own community. Grades 5-8.

28. *Elementary, Volume 6, History* (MECC) includes a program called *Nomad* that teaches map reading skills. It suggests an activity that takes students exploring their own town. Reinforce the map reading skills *Nomad* teaches by having students create a local map. Assign groups of students to different sections of town (depending upon how large a geographical area your school serves, you might choose just a few blocks around the school). Students should collect as much information as possible about their sector: names and directions of major streets, buildings, lakes, and so on. When all the information is in, the class draws a map of the neighborhood or city. Compare the class map to an actual one. How close did the students come? Grades 3-6.

29. *Hat in the Ring* (Micro-Ed, Inc.) is a two-player presidential election game in which each player takes the part of a candidate and makes campaign decisions. Have students who have played this game interview local politicians or campaign workers. What is a real campaign like? How do candidates create an image? What problems must they overcome? Have each student list those things he or she thinks most influence a successful campaign. Grades 6 and up.

30. *Market Place* (MECC) includes four economic simulation programs. Students must make decisions in the areas of economic pricing, marketing, advertising, and profit. They apply what they learn playing these games to a business of their own design. What would they have to think about to run a successful lawn-mowing business, for example? What forces out of their control would influence the business? Grades 4-8.

31. The program *Oregon Trail* (MECC) simulates some of the dangers pioneers encountered on the trek west. The program designers used actual settlers' diaries to research the problems these pioneers encountered. Have your students read about the Westward Expansion. They can draw upon their readings and the Oregon game to write their own "pioneers'" diaries. Once students have completed their diaries, divide the class into groups to give dramatic readings from their diaries, a la *Spoon River Anthology*. Grades 4-8.

32. In *States and Capitals* (Atari, Inc.) the computer draws a map. The player must identify the state and its capital. Use this program with a small

group and try the following activity. Create or purchase a jigsaw puzzle of the states. Bring this and a large piece of oaktag to class. When a student correctly guesses a state presented by the computer, he or she gets to locate the jigsaw piece of that state where he or she thinks it belongs on the oaktag (north, east, south, or west; below Nebraska or next to Kentucky). The group continues playing with both the computer game and the puzzle until the map is complete. Grades 4-6.

Early childhood

33. *Jeep Jamboree* (Microgram, Inc.) is a counting game that uses graphics to teach numbers from 1 to 10. Tell pupils that they are going to be part of a jeep convoy. They can choose the color of their jeeps. Then give each one a number from 1 to 10 or 20, depending upon the student's level. To join the jamboree the students must line up in the correct numerical order. Grades PreK-1.

34. Little Bee Educational Programs' *Missing Letter* provides drill in the alphabet. Create a missing letter circle game. Lay out letters of the alphabet within the circle that the students have formed. Choose one child to hide a letter while the other students have their eyes closed. Students open their eyes and try to guess the missing letter. The child who guesses first is next to hide a letter. Try a similar game as an adjunct to *Missing Number Game* (Micrograms Inc.). Grades PreK-1.

35. After students have practiced with *Letters and Numbers* (Teaching Tools), have them create letters and numbers from modeling dough. Once it has hardened, put some of the letters and numbers into a grab bag. Let each child in turn reach in, feel a letter or number, and guess what it is. The child can pull the letter or number out of the bag to see if the guess was right. Grades PreK-1.

36. *Hodge Podge* (Dyancomp, Inc.) uses graphics and sound to teach the alphabet. Here's a Christmas-time activity to use in conjunction with this program. Have children draw animal ornaments for different letters of the alphabet. Have them put the appropriate letter on each animal. When tree-trimming time comes, randomly assign letters to all the children. They must then find the ornament that matches their letter and pin it on the tree. Grades PreK-1.

37. Spinnaker Software's *Face Maker* program presents a blank face that the child can complete by selecting from menus of eyes, ears, hair, and so on. This program helps develop fine discrimination. Pair off children who have used *Face Maker*. Have them describe one another's faces. How are they similar? How are they different? Have the children draw pictures of one another. Grades K-3.

CHAPTER 7

Where to Go from Here

Here is an extensive list of resources to get you started with computers. It's not exhaustive by any means, but it will get you started. In addition to the resources listed here, you might call your state department of education to see if they are aware of educational computer user groups in your area or of a nearby school district with an active computer program.

Educational Computing Distributors

Academic Software
22 E. Quackenbush Ave.
Dumont, NJ 07628
201/385-2395

Activity Resources Co., Inc.
29655 Hathaway Ave.
P.O. Box 4875
Hayward, CA 94540
415/782-1300

American Educational Computer, Inc.
525 University Ave.
Suite 1400
Palo Alto, CA 94303
412/324-2811

A.P. Computer Products
8 Division St.
Holtsville, NY 11742
516/698-8636

Assn. for Computers in Mathematics and Science Teaching
P.O. Box 4455
Austin, TX 78765
512/258-8083

BGS Enterprises
BG Sound Division
60 East 9 St. New York, NY 10003
212/674-1185

Com-Pute Services
P.O. Box 3361
Oak Park, IL 60303
312/386-7733

Computer Center
31 East 31 St.
New York, NY 10016
212/889-8130

Computer Courseware Services
Div. of EMC Publishing
300 York Ave.
St. Paul, MN 55101
800/328-1452

Computer Discount of America, Inc.
15 Marshall Hill Rd.
West Milford Mall
West Milford, NJ 07480
800/526-5313

Computer Mat
P.O. Box 1664-J
Lake Havasu City, AZ 86403
602/855-3357

The Computer Store
55 Union Ave.
P.O. Box K
Sudbury, MA 01776
617/879-3700

Creative Computing Software
39 E. Hanover Ave.
Morris Plains, NJ 07950
800/631-8112

Creative Publications
3977 E. Bayshore Rd.
Palo Alto, CA 94303
415/968-3977

Educational Computing System
106 Fairbanks Rd.
Oak Ridge, TN 37830
615/483-4916

Educational Teaching Aids
159 W. Kinzie
Chicago, IL 60610
312/644-9438

Eye Gate Media, Inc.
146-01 Archer Ave.
Jamaica, NY 11435
212/291-9100

Fisher Scientific Co.
Educational Materials Div.
4901 W. LeMoyne Ave.
Chicago, IL 60651
312/378-7770

Follett Library Book Company
4506 Northwest Highway
Crystal Lake, IL 60014
800/435-6170

Huntington Computing
1945 S. Dairy
P.O. Box 787
Corcoran, CA 93212
209/992-4481

J.L. Hammett Company, Inc.
Hammett Place
P.O. Box 545
Braintree, MA 02184
800/225-5467

K-12 MicroMedia, Inc.
172 Broadway
Woodcliff Lake, NJ 07675
201/391-7555

Learning Systems, Ltd.
P.O. Box 9046
Ft. Collins, CO 80525
303/482-6193

The Learning Tree
45615 Van Dyke
Utica, MI 48087
313/739-5900

Mafex Associates, Inc., Publishers
90 Cherry St.
P.O. Box 519
Johnstown, PA 15907
800/458-0151

The Micro Center
P.O. Box 6
Pleasantville, NY 10570
914/769-6002

Micro Computer Service, Inc.
2885 E. Aurora Ave.
Suite 14B
Boulder, CO 80303
303/447-9471

Misco, Inc.
P.O. Box 399
Holmdel, NJ 07733
800/631-2227

Opportunities for Learning
8450 Lurline Ave.
Chatsworth, CA 91311
213/341-2535

Peripheral Systems, Inc.
225 East St.
Winchester, MA 01890
617/729-7715

Queue, Inc.
5 Chapel Hill Drive
Fairfield, CT 06432
203/335-0908

Rainbow Computing, Inc.
19517 Business Center Drive
Northridge, CA 91324
213/349-0300

Saddleback Educational, Inc.
720-B South Vail Ave.
Montebello, CA 90640
213/721-5011

Scholastic, Inc.
50 West 44 Street
New York, NY 10036
212/944-7700

School Specialty Supply, Inc.
3525 South Ninth St.
P.O. Box 1327
Salina, KS 67401
913/827-0451

Society for Visual Education
The Singer Company
1345 Diversey Pkwy.
Chicago, IL 60614
213/525-1500

Sunburst Communications
39 Washington Ave.
Pleasantville, NY 10570
800/431-1934

Terrapin, Inc.
380 Green St.
Cambridge, MA 02139
617/492-8816

Transnet Corporation
1945 Route 22
Union, NJ 07083
201/688-7812

Trumble Data/Comm. Co.
530 North 3 St.
P.O. Box 50790
Jacksonville Beach, FL 32250
904/249-7066

Unicom Div. United Camera, Inc.
297 Elmwood Ave.
Providence, RI 02907
401/467-5600

Microcomputer Manufacturers

Apple Computer, Inc.
10260 Bandley Drive
Cupertino, CA 91770
213/575-8614

ATARI, Inc.
Home Computer Division
1196 Borregas Ave.
Sunnyvale, CA 94086
800/538-8547

Bell & Howell Co.
7100 N. McCormick Rd.
Chicago, IL 60645
312/262-1600

Commodore Business Machines
The Meadows
487 Devon Park Rd.
Wayne, PA 19087
215/687-9750

Control Data Corporation
8100 34 Ave. South
P.O. Box O
Bloomington, MN 55440
612/853-8100

Digital Equipment Corp.
Educational Computer Systems
200 Forrest St.
Marlboro, MA 01752
617/467-6109

Epson America, Inc.
3415 Kashiwa St.
Torrance, CA 90505
213/539-9140

Franklin Computer Corp.
7030 Colonial Hwy.
Pennsauken, NJ 08109
609/488-1700

Heathkit Education Systems
Zenith Radio Corporation
Benton Harbor, MI 49022
616/982-3200

Hewlett Packard Co.
Personal Computer Div.
1010 North East Circle Blvd.
Corvallis, OR 97330
503/757-2000

Honeywell Information Systems, Inc.
200 Smith St.
Waltham, MA 02154
617/895-6000

IBM
Information Systems Div.
P.O. Box 1328
Boca Raton, FL 33432
800/447-4700

Monroe Systems for Business
The American Rd.
Morris Plains, NJ 07950
201/540-7600

NEC Home Electronics, Inc.
1401 Estes Ave.
Elk Grove Village, IL 60007
312/228-5900

North Star Computers, Inc.
14440 Catalina St.
San Leandro, CA 94577
415/357-8500

Osborne Computer Corp.
26500 Corporate Ave.
Hayward, CA 94545
415/887-8080

Radio Shack
Tandy Corporation
1600 One Tandy Center
Fort Worth, TX 76102
817/390-3272

Sinclair Research Ltd.
50 Staniford St.
Boston, MA 02114
617/742-4826

Sony Corporation of America
Microcomputer Products Div.

Sony Drive
Park Ridge, NJ 07656
212/930-1000

Texas Instruments, Inc.
Personal Computer Division
P.O. Box 10508
Lubbock, TX 79408
800/858-4565

Wang Laboratories, Inc.
One Industrial Ave.
Lowell, MA 01851
617/459-5000

Clearinghouses

EPIE Institute
P.O. Box 620
Stony Brook, NY 11790
516/246-8664
Consumer agency for educational materials produces reports on hardware and software.

Microcomputer Education
Applications Network (MEAN)
256 North Washington St.
Falls Church, VA 22046
703/536-2310
Helps educators develop and market software. Members' newsletter covers software sources and applications, as well as industry news.

MicroSIFT
Northwest Regional Educational Laboratory
300 South West 6 Ave.
Portland, OR 97204
503/248-6800
Software evaluation clearinghouse.

SOFTSWAP
San Mateo County Office of Education
333 Main St.
Redwood City, CA 94063
415/363-5470
Free software exchange of teacher-evaluated public domain programs.

Directories

The Blue Book for the Apple Computer
Visual Materials, Inc.
4170 Grove Ave.
Gurnee, IL 60031
312/249-1710
1983 edition includes over 700 producers and 7,000 products. The 900-page directory contains products in 57 categories.

Commodore Resource Encyclopedia, Third Edition
Commodore Business Machines
1200 Wilson Drive
West Chester, PA 19380
215/431-9100
Lists hardware overviews, software by categories, and hardware vendors for Commodore products.

EPIE Report on Microcomputer Courseware
EPIE Institute
P.O. Box 620
Stony Brook, NY 11790
515/246-8664
Detailed analysis of major microcomputer math packages.

Instructor's 1983/84 Computer Directory for Schools
Instructor Magazine
757 Third Ave.
New York, NY 10017
212/888-3400
Complete listing of hardware, software, and publications of interest to K-12 educators.

Reference Manual for Instructional Uses of Microcomputers
GEM Research
Software Research Corp.
Discovery Park
University of Victoria
PO Box 1700
Victoria, BC 8W262
604/477-7246
Contains an annotated index and 1,000 excerpts from the catalogs of 50 producers and distributors of microcomputer products for grades K-12. Contains descriptions and evaluations of 200 programs.

Softswap
Softswap —SMERC Library
San Mateo County Office of Education
333 Main St.
Redwood City, CA 94063
415/363-5470
Public domain software is made available to educators either free or at nominal charge. Software available for Apple, Atari, Radio Shack, and Commodore PET computers.

The Software Finder
Dresden Associates
PO Box 246

Dresden, ME 04342
207/737-4466
Describes 2,800 educational software products for Apple, Commodore PET, TRS-80, TRS-80 Color Computer, Atari 400/800, Commodore 64, and VIC 20 microcomputers. Includes both administrative and instructional software.

Swift's Educational Software Directory—Apple II
Sterling Swift Publishing Co.
7910 South I.H. 35
Austin, TX 78744
540 pages of software information organized by subject, publisher, and title. Includes a listing of review sources.

Texas Instruments Software Catalog for the Home Computer, 1983 edition
Texas Instruments
PO Box 225012
MS 84
Dallas, TX 75265
800/858-4565
Lists software for TI computer indexed by category includes list of software producers.

TRS-80 Educational Software Source Book
Radio Shack
Tandy Corp. 1600 One Tandy Center
Fort Worth, TX 76102
817/390-3523
Includes information on TRS-80 educational software products and user groups.

VanLove's 1983 Apple II/Apple III Software Directory, Vol. II
Advanced Software Technology, Inc.
PO Box 2038
Shawnee Mission, KS 66201-1038
913/648-4442
Lists Apple software and peripherals, including instructional and administrative software.

Books on Computers and Programming

ATARI Games and Recreations
Kohi, Herb et al
(Reston Publishing Co., 1982)
Basic introduction to the ATARI 400/800. Teaches programming to the novice through the use of games. Includes ready-to-run program listings.

Are You Computer Literate?
Billings, Karen et al
(Dilithium Press, 1979)
Self-instruction book on the capabilities, applications and implications of computers. Quizzes at beginning of chapters and final exam chart progress. Each chapter contains activities and information sources.

Arithmetic Teacher: Microcomputers
Hill, Jane M., editor
(National Council of Teachers of Mathematics, 1983)
Special *Arithmetic Teacher* issue focuses on microcomputers in elementary school mathematics. Includes articles on the microcomputer's capabilities and applications.

The Beginner's Guide to Buying a Personal Computer
Mansfield, Richard, et al.
(COMPUTE! Publications, Small System Services, Inc., 1982)
Nontechnical handbook teaches the basics of evaluating and selecting a personal computer. Includes personal computer specifications charts and buyer's guide.

DON'T! Or How To Care For Your Computer
Zaks, Rodnay
(Sybex Inc, 1981)
Gives specific information on how to avoid technical and other problems. Also includes trouble-shooting advice on peripherals and disks.

Hands-on BASIC for the IBM Personal Computer
Peckham, Herbert
(McGraw-Hill Book Co. Webster/EDL/ McGraw-Hill Div., 1982)
Self-study guide for beginners.

Hands-on BASIC with a PET
Peckham, Herbert
(McGraw-Hill Book Co., Webster/EDL/ McGraw-Hill Div., 1979)
Teaches programming by having user devise programs to solve everyday problems. Includes examples, problems, and test.

How to Buy a Personal Computer
Shrum, Carlton
(Alfred Publishing Co., Inc, 1981)
Practical introduction to microcomputer hardware and software. Includes chart comparing many popular systems. Updated quarterly.

Introduction to Computers in Education for Elementary and Middle School Teachers
Moursund, David
(International Council for Computers in Education, 1981)

For self-instruction, in-service or pre-service courses. Includes over 75 activities.

Logo Language: Learning Mathematics through Programming
Feurzeig, W, et al.
(Entelek, 1978)
Contains Logo teaching sequences in a variety of mathematical subjects and levels of difficulty.

Learning TRS-80 BASIC
Lien, David A.
(CompuSoft Publishing, 1982)
Step-by-step instructions for users of Radio Shack computers. Includes sample programs plus questions and answers with most chapters.

Microcomputers
(National Council of Teachers of Mathematics, 1981)
Special issue of *Mathematics Teacher* on computers in mathematics education. Covers selecting computers and starting high school or junior high school program. Includes a buying guide and a bibliography.

Microcomputers in Education
Naiman, Adeline
(TERC Technical Education Research Centers, 1982)
Written to help movies plan and carry out educational computing programs. Includes reference section and a decision model for microcomputer purchase.

Mindstorms
Papert, Seymour
(Basic Books Inc, 1980)
Presents Papert's vision of education in the future. Discusses Logo.

Pascal: A Considerate Approach
Price, David
(Prentice-Hall Inc, 1982)
Presents a complete introduction to programming Pascal. Neither prior programming experience nor advanced mathematical training assumed.

A Planning Guide to Successful Computer Instruction
Peters, G. David, et al.
(Electronic Courseware Systems, Inc., 1981)
Covers selection and evaluation criteria for hardware and software, developing and managing computer centers, and sources of hardware and software.

Pocket Computer Primer
Librach, Hank
(Micro Text Publications Inc., 1982)
Introduction to computer literacy using the new, low-cost Sharp and TRS-80 pocket computers. Covers computer science, ecology, math, geography, programming. Accompanying software available separately.

Practical Guide to Computers in Education
Coburn, Peter, et al.
(Addison-Wesley Publishing Co., 1982)
Covers practical applications of computers at all educational levels and in all subjects for teachers, administrators, and parents.

School Administrator's Introduction to Instructional Use of Computers
Moursund, David
(International Council for Computers in Education, 1982)
Booklet for administrators or school board members on computers and their effect on the curriculum.

Start with BASIC on the Commodore VIC-20
Monro, Don
(Reston Publishing Co., 1982)
Guide to programming the VIC-20. Covers graphics and includes exercises and step-by-step instructions.

TRS-80 Microcomputer Information Handbook for Educators
(Radio Shack)
Provides basic information on applications of TRS-80 computers to classroom instruction.

Using Computers in Mathematics
Elgarten, G, et al.
(Addison-Wesley Publishing Co., 1983)
Textbook introduces computer concepts and mathematics applications. For introductory computer science classes.

What Computers Can Do
Spencer, Donald D.
(Camelot Publishing Co., 1982)
Describes in simple language how computers are used in medicine, law enforcement, education, business, fine arts, factories, space, government, newspapers, supermarkets, department stores, and sports.

Your First Computer
Zaks, Rodnay
(Sybex Inc., 1980)
Beginner's guide to small computers. Provides information on how to select, buy and use a personal computer and accompanying software.

Educational Computing Periodicals

Apple Education News
Polin, Glen, editor
(Apple Computer, Inc., 1980, 3/yr)
News of educational applications of Apple products, plus announcements of new software and books.

Classroom Computer News
Olds, Henry F., editor
(Intentional Educations, Inc., 1980, 6/yr.)
Magazine about educational computing for teachers and administrators.

The Computing Teacher
Ricketts, Dick, editor
(International Council for Computers in Education, 1979, 9/yr.)
Covers instructional computing from pre-school through high school. Articles about computers, teacher education, and the impact of computers on the curriculum.

Educational Computer Magazine
Hiraki, Joan, editor
(Educational Computer Magazine, 1981, bimonthly)
Magazine for specialist, educator, and administrator. Covers computer field, including special education and funding.

Electronic Education
Lobello, Sharon T., editor
(Electronic Communications Inc., 1981, 9/yr.)
Nontechnical magazine about technology that effects education. For teachers and administrators. Regularly offers special pull-outs.

Electronic Learning Magazine
Roberts, Jack, editor
(Scholastic, Inc., 1981, monthly)
Nontechnical magazine provides educators with practical information about technological aids. Covers videodiscs, video cassette recorders, calculators, and any computer-based technology.

Journal of Computers in Mathematics and Science Teaching
Marks, Gary H., editor
(Assn. for Computers in Mathematics and Science Teaching, 1981, quarterly.)
Covers applications in and research on teaching math and science with computers. Includes software and program listings, book reviews, bibliographies.

M.A.L.A.:
Micro-Assisted-Learning-Aids
(Comm★Data Systems, Inc., n.a. 8/yr.)
Each issue contains four educational programs on cassette in a variety of elementary school subjects. Descriptive instruction sheets come with each issue.

T.H.E. Journal
Charp, Sylvia, editor
(T.H.E. Journal, Information Synergy, Inc., 1973, 8/yr.)
Magazine covers technical products and issues at all levels of education and in industrial training and vocational education.

Turtle Talk
(Harvest Publishing, 1982, bimonthly)
Logo newsletter covers applications. Logo in special education, software and book reviews, Logo news and calendar.

WINDOW
Olds, Henry F., editor
(Window, Inc., 1982, 5/yr.)
Programs about software and programming published on disk for Apple II owners.

General Computing Publications

Creative Computing Magazine
Ahl, David H., editor
(Ahl Computing, 1974, monthly)
General computing magazine featuring applications and reviews. Some features on educational computing.

Personal Computing Magazine
Gabel, David, editor
(Hayden Book Company, Inc., 1977, monthly)
Nontechnical personal computing magazine. Includes monthly articles about educational. leisure-time, managerial, and professional computing.

Popular Computing
Morgan, Chris, editor
(Byte Publications, Inc., 1981, monthly)
Consumer magazine about small computers for business, home, and education.

Syntax Newsletter
Zevnik, Anne, editor
(Sinclair Research Ltd., 1980, monthly)
Offers programs and advice to and from Sinclair computer users.

TRS-80 Microcomputer News
(Radio Shack, 1979, monthly)
Newsletter for TRS-80 owners. Includes articles, product information, programs. Twelve-month subscription free to purchasers of new TRS-80 systems.